The Process of Other-Focus: A Synthetic Social Psychophysiological Model

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Abstract

BETHANY E. KOK: The Process of Other-Focus: A Synthetic Social Psychophysiological Model
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Human beings do not exist in isolation from one another. People thrive on social interactions and relationships, and suffer when these things are lacking. In relationships, people both give and receive valuable resources: time, money, attention, assistance. Such resources are vital for psychological health and well-being, but are largely unavailable to individuals unable to look outside of the self. The ability to look beyond the self, therefore, is a vital element of well-being.

A psychophysiological model of other-focus is proposed to describe the initiating factors, components and consequences of moments in which one looks beyond the self. The vagus nerve, in concert with oxytocin, is hypothesized to initiate the other-focused state by directing attention to others and generating positive emotions in the moment, leading to other-focused behaviors. Over time, frequent experiences of other-focus result in enhanced relationship quality, psychological well-being and physical health.

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Introduction

Human beings do not exist in isolation from one another. People thrive on social interactions and relationships, and suffer when these things are lacking (Baumeister & Leary, 1995). To rewrite a popular song lyric, people who *have* people are the happiest people; they are also healthier (Unchino, Cacioppo, & Kiecolt-Glazer, 1996), and make better decisions (Baumeister, DeWall, Ciarocco & Twenge, 2005). Not only do people need others, but others also need them. Children require attention and care, thus adults must be motivated to provide resources and to form relationships for mutual support and protection. Other-focus is essential: without the ability to look beyond their own needs and desires, people are crippled, unable to care effectively for their children, form relationships or experience psychological health and well-being.

Despite the central role of relationship formation and social support in daily life, attempts to explain how and when individuals come to engage in affiliative, other-focused behavior are fragmented and incomplete. We do not know why people "click" sometimes and not at other times, or why "loneliness" is part of our emotional repertoire, or why other pleasant activities (like solo sports, reading, or working creatively) do not substitute for being in the presence of and interacting with others in a positive way. What is it that drives us to affiliate and rewards us when we do? Human beings are social animals, but what is it that makes us so?

We know that interacting with others is pleasant and self-reinforcing. Many theories exist to explain why social interactions are positive once begun. Human touch stimulates the release of oxytocin, a neurochemical that increases feelings of physical well-being and possibly even positive affect (Uvnas-Moberg, Arn & Magnusson, 2005). Forming relationships expands and complexifies the self, a process experienced as pleasant (Aron & Aron, 1986). Relationships also offer utilitarian rewards in the shape of resources shared and burdens lessened. None of these benefits, however, are unique to relationships. Orgasms and exposure to stress can both trigger oxytocin secretion without the presence of others (Henry & Wang, 1998; Carmichael, Warburton, Dixen & Davidson, 1994). Relaxation, vacations and television-watching can all provide temporary relief from the burdens of modern life, and complex selves can be built through personal development and learning as well as through friendships. Thus, the rewards of relationships alone cannot explain why individuals undergo the considerable personal risks involved in the formation of a new relationship. The incidence of spousal abuse, date rape and scams, not to mention the potential for rejection and embarrassment, remind us that reaching out to others is not always a winning proposition. In the age of the internet, we can achieve entertainment, sustenance, information and even livelihood without encountering another human being. Yet, despite the risk, we continue to reach out to others. Why might this be?

The propensity to affiliate may be learned. Attachment theory suggests that an individual's experiences with caregivers as an infant are formative, significantly impacting his or her ability to form relationships later in life (Bowlby, 1971). Theorists suggest that such learning occurs early, and is based on the child's expectation of the rewards and punishments that accompany social interactions. Attachment style is said to be an enduring trait, shaping interactions and relationships throughout the individual's youth and adulthood.

Attachment theorists find that people characteristically exhibit one of three attachment styles: secure, anxious/insecure, or avoidant (Mikulincer & Shaver, 2007). Compared to anxious or avoidant individuals, securely attached individuals are more likely to focus on the other, experience compassion and act to help, regardless of whether the recipient of help is their own child (Crowell and Feldman, 1988, 1991), a romantic partner (Carnelley, Pietromonaco, & Jaffe, 1996) or a stranger (Mikulincer et al., 2003).

Given the significant behavioral effects in adulthood of early infant experiences, a primary question raised by attachment research is how attachment style is encoded. The individual's own reward system may be co-opted to reinforce attachment behaviors learned in infancy (Henry & Wang, 1998). The nature of such reward systems and the impact of early experience on physiology, however, are questions unaddressed by attachment theory.

Perhaps the desire to affiliate is genetic. In the evolutionary past, affiliating with others provided vital protection from predators, increased supervision of young and possible sharing of resources. Selective Investment Theory (SIT) posits that our ability and tendency to form social bonds and behave prosocially was borne from the successful reproduction of our affiliation-minded ancestors (Brown & Brown, 2006). When caring for another, an individual sacrifices resources that could be devoted to the self. SIT attempts to answer to the question of how our capacity for care evolved in the context of reproductive success. Individuals are motivated to engage in costly long-term investment with others to the extent that they share fitness interdependence and a social bond. Once an individual has formed a social bond with another, and the two mutually benefit from investing resources in one another, prosocial behavior naturally occurs.

Despite the vital role that social bonds play in SIT, the processes that lead to their formation are largely unexplained by Brown and Brown. It is unclear how we form the positive associations that are the basis for social bonds, though some theorists have proposed that positive emotions play a role (Cohn & Fredrickson, 2006). Likewise, the path from ancestral behavior to modern-day activities is only lightly sketched. We do not know how our bodies, constructed via the blueprints of these ancestral genes, might go about predisposing us to form the positive associations between people that lead to social bonds. While it is reasonable to expect that ancestral humans grouped together to survive, psychological theories to date have not posited much in the way of mechanisms that might motivate such grouping in the present.

Affiliation could also be physiologically driven. A number of models treat oxytocinergic activity as the basis of sociality and coping with stress. Oxytocin is involved in pair-bonding in prairie voles (Cho, DeVries, Williams & Carter, 1999), as well as social touch (Light, Grewen & Amico, 2005) and parenting (Taylor et al., 2000) in humans, and diverse other biological processes from sex to cardiovascular reactivity (Uvnas-Moberg, 2003). OT models have generated a rich store of empirical evidence concerning how mammals react with stress and how social bonds are formed.

Gonadal steroids and oxytocin are secreted in response to stress, initiating species-preservative behaviors such as caring for and protecting young (Henry & Wang, 1998). These chemicals allow the individual to utilize social resources to diffuse stress.

The calm and connect model (Uvnas-Moberg, Arn & Magnusson, 2005) describes an other-focused mode of cognition, behavior and physiology, in which environmental stimuli such as touch or safety cues initiate the secretion of oxytocin, leading to activation of the parasympathetic nervous system, suppression of norepineprhine secretion and increased affiliative behaviors. In addition, Taylor's Tend and Befriend model posits that social distress induces oxytocin secretion as a way of promoting affiliative behavior (Taylor, 2006). Tend and befriend responses to distress enhance the likelihood of survival of mother and child in dangerous situations by motivating relationship-oriented behaviors, such as quieting and caring for a vulnerable child and seeking out the support and resources of others for mutual protection.

In both of these models, oxytocin-secretion is elicited by an outside stimulus (security cues or stress) and results in affiliative, support-seeking behavior. What is lacking, however, is an explanation of how oxytocin initiates such behavior. Oxytocin's calming effect, which aids in coping with stress, is clearly related to its ability to decrease activity in the Hypothalamic-Pituitary-Adrenal (HPA) axis, a bodily system involved in stress responses, while stimulating the down-regulatory peripheral nervous system (Uvnas-Moberg, 1994). To the extent that theories focus on the down-regulation of cardiovascular activity and the cognitive and behavioral consequences of low physiological arousal, they are empirically well-supported. When oxytocinergic theories move toward other-focused behavior, however, there is little theoretical groundwork to be found. The "calm," unaroused state promoted by oxytocin does not necessarily lead to any particular behavior, and indeed could be more likely, on its own, to lead to relaxation and passivity. The manner in which OT creates affiliative urges is currently unknown.

Oxytocinergic theories are one of a number of psychophysiological perspectives on affiliation. The polyvagal theory states that it is the Xth cranial nerve, the vagus, that makes affiliation possible (Porges, 1995). Porges proposes that the vagus is an evolved mammalian adaptation necessary for parenting slow-maturing young. Vagal activation occurs through a process of neuroception, in which the nervous system potentiates the appropriate physiological response to a safe environment without cognitive intervention (Porges, 2003). The vagus motivates other-focused behavior through its role in controlling facial expression, middle ear muscles, eye gaze and emotions, which are collectively known as the Social Engagement System (Porges, 1995). Vagal activity predisposes adults to attend and respond to the communication signals of their own species.

While the polyvagal theory is described as a theory of embodied other-focus, in practice its applications have been mainly in the fields of psychopathology and social maladjustment and their relationships with low vagal tone (Porges, 2007). Less empirical work has focused on the effects of characteristically high vagal activity and the presence, rather than absence, of affiliative behaviors. In addition, the proposition that a complex social process such as affiliation occurs through the non-conscious mechanism of neuroception seems inadequate to explain the myriad of positive social behaviors (listening empathetically to the story of a friend's bad day, holding the door for an overloaded colleague) that humans engage in each day.

The psychological, evolutionary and physiological perspectives described above contribute valuable information to the understanding of other-focus, but each is incomplete. Most work on other-focus connects a psychological or physiological state to a behavioral outcome without explaining either how a person might come to be in that state, or how such a state leads to the behavior observed. For instance, making individuals feel secure increases their likelihood of behaving prosocially toward another person (Mikulincer, Hirschberger, Nachmias, & Gillath, 2001), but we do not know how that secure feeling translates itself into prosocial behavior. Similarly, socially adept children have higher resting vagal tone (Eisenberg, Fabes, Murphy, Mazk, Smith & Karbon, 1995), but the process through which vagal tone and social skill are related remains to be explained.

A model of other-focus is proposed to account for peoples' propensity to attend to and invest in others, both in the moment and over time. This model synthesizes insights from a number of psychological and psychophysiological theories in order to cover the range of the other-focus process, from initiating factors to long-term implications for health and well-being. Table 1 illustrates the connections between the other-focus model and current theories.

The purpose of this work is to describe the other-focus model and its utility as a framework for organizing existing empirical findings and generating new hypotheses, and to test some specific predictions of the model using archival data analysis. I will begin with a description of the model, situating it within existing empirical work on other-focus. I emphasize throughout the connections that can be uniquely derived from a combination of social and physiological approaches. Such connections comprise the bulk of the model's potential contribution to the study of other-focus. I will also identify areas where the predictions of the model are untested. I will conclude by describing the results of some initial tests of the other-focus model and the next steps to be taken in exploring the process of other-focus model.

Chapter 2

The Other-Focus Model

A moment of other-focus is composed of a cascade of physiological and psychological responses initiated by contruals. These responses unfold over time, with feedback loops that may intensify or extend the other-focused state. These responses, in the order that they typically occur, are: *1a)* Construal of the environment as safe, secure and controllable, *1b)* the presence of a conspecific who is appraised as receptive to positive social interaction *2)* oxytocin-secretion, *3)* vagal activation, *4a)* other-focused attention, *4b)* positive emotions, *5)* positive other-focused behavior and, if the individual continues to experience many moments of other-focus in a variety of situations and with a range of individuals over time, *6*) accrued relationship resources and long-term benefits for physical and psychological health. Figure 1 illustrates this new model.

1. Construal of the environment as safe, secure and controllable and appraisal of the present other as receptive

Other-focus is initiated when the individual construes the immediate environment as safe, secure and/or controllable[1] and when a conspecific is present who is appraised as receptive to positive social interactions. An individual will construe the environment as controllable to the extent that he or she believes resources are available to successfully cope with challenges that may arise (Lazarus & Folkman, 1984). As resources

[1] Desire to affiliate may also increase with anxiety or fear (Schachter, 1959), but this affiliation is instrumental in nature and aimed at addressing a current threat rather than relationship-building. Construals of safety and security can also be relative, as when two soldiers bond while resting between missions in their camp while in enemy territory.

accumulate, the individual will construe more situations as controllable, rather than uncontrolled and threatening, and therefore become more likely to experience moments of other-focus.

Cues for safety and control vary by the individual, but at the most basic level they include positive emotions felt by the self or expressed by others, warm physical touch and familiar environments with positive associations. Individuals experiencing positive emotions are more likely to help a stranger pick up spilled papers (Isen & Levin, 1972), to extend social support to co-workers (Tsai, Chen & Liu, 2007), and to engage in a broad range of other prosocial and altruistic acts (Lyubomirsky, King & Diener, 2005).

Work on boosting attachment security has focused on the effects of priming a sense of security in adults. Individuals primed with "secure" words were more likely to endorse self-transcendent values of connection and caring for others (Mikulincer et al., 2003) and to seek support from others (Mikulincer, Hirschberger, Nachmias, & Gillath, 2001). While the effects of primes fade quickly, this work indicates that contextual factors have the capacity to elicit other-focused thoughts and behavior.

Over time, individuals learn to construe formerly neutral cues as cues of safety or affiliation (a stranger becomes a friend, a house becomes a home). In doing so, they develop a broad portfolio of stimuli that may initiate other-focus. A prediction of the other-focus model is that an individual who experiences frequent moments of other-focus will possesses a particularly broad range of situations that are construed as safe and controllable.

Since other-focus is a fundamentally social process, the presence of a conspecific is necessary as the target for other-focused attention, emotion and behavior. An initial appraisal of receptivity will forestall attempts to invest in others who are hostile, distracted, or otherwise engaged, thus protecting the individual from costly waste of resources. As the individual experiences more moments of other-focus and, through those moments, more social interactions, he hones the ability to accurately appraise others' receptivity. This increase in perceptual acuity will increase the number of positive social interactions the individual engages in and decrease the number of negative social interactions that might result from misapprehending another's interest in social contact. As a result, the individual will be able to invest resources and time in others more efficiently and productively, accruing resources at a faster rate. A prediction of the other-focus model is that individuals who experience many moments of other-focus will be more skilled in deciphering cues of social receptivity, such as facial expression, posture and other non-verbal mannerisms.

2. Oxytocin-secretion

Oxytocin is a neuropeptide secreted in response to affiliation-type behaviors such as warm touch or lactation in humans and other mammals (Grewen, Girdler, Amico & Light, 2005; Carter, Williams, Witt & Insel, 1992). Construals of stress as controllable (a.k.a., "challenge") and environments as safe and secure both initiate oxytocin secretion (Henry & Wang, 1998; Uvnas-Moberg, Arn & Magnusson, 2005). Oxytocin secretion serves to suppress sympathetic nervous system activity and stimulate parasympathetic nervous system activity, decreasing arousal (Uvnas-Moberg, 1998). Pregnant women with high levels of endogenous oxytocin exhibit more other-focused characteristics, including calm affect and lack of aggression, relative to non-pregnant women (Uvnas-Moberg, Widstrom, Nissen & Bjorvell, 1990). When OT levels are high, the individual experiences psychological well-being and increased motivation to trust and have positive social interactions with others (Kosfeld, Heinrichs, Zak, Fischbacher & Fehr, 2005; Uvnas-Moberg, 1998). These factors increase the likelihood that an individual will be willing and able to focus on others in a positive way.

Other-focused positive emotions such as love and trust increase oxytocin secretion (Turner et al., 1999; Gonzaga, Turner, Keltner, Campos & Altemus, 2006; Zak, Kurzban & Matzner, 2005; Silvers & Haidt, 2008). Oxytocin secretion may also be triggered directly by safety and security construals and the presence of a benign other. Previously neutral stimuli can come to stimulate oxytocin secretion through classical conditioning, as old triggers are associated with new situations (Wakerley et al., 1994; Carter, 1998). This permits triggers for oxytocin to change as individuals encounter new situations and individuals and construe old environments differently, maintaining the capacity for other-focus across changing life situations.

Oxytocin plays a role in the formation of new social bonds. Exogenous oxytocin administered nasally increases trust in humans during an exchange game (Kosfeld, Heinrichs, Zak, Fischbacher & Fehr, 2005). In addition, being the object of another's trust in an exchange game causes the trust recipient to exhibit increased levels of oxytocin (Zak, Kurzban & Matzner, 2005). Trust recipients who respond to being trusted with increased levels of oxytocin are also more likely to reciprocate trust (Zak, Kurzban & Matzner, 2005), creating an upward spiral of other-focused behavior and physiological responses that leads to social bonds.

In the other-focus model, the beneficial effects of OT are proposed to be partly due to the ability of oxytocin to directly increase positive emotions, but mostly through the capacity of oxytocin to increase vagal activity. In humans, warm touch-type stimulation increases vagal activity and decreases adrenergic and sympathetic nervous system activity, a response pattern that may be coordinated by oxytocin (Uvnas-Moberg, 1997).

Work in animals suggests that oxytocin can initiate vagal activation in some mammals. The majority of research on the relationship between oxytocin and the vagus has been performed on rats. Rats have oxytocin receptors within the vasculature, which is innervated by the vagus (Jankowski et al., 2000). In the lab, oxytocin applied to the dorsal motor nucleus of the vagus nerve in the brain tissue of a rat stimulates dose-dependent neural firing in that tissue. This oxytocinergic effect occurs exclusively in that area of the rat brain (Charpak, Armstrong, Muhlethaler & Dreifuss, 1984).

Oxytocin, whether centrally released or exogenously administered, is related to positive emotions and affiliative behavior. Further research is necessary to test the assertion of the other-focus model that OT secretion in humans activates the vagus. A prediction of the other-focus model is that the known prosocial effects of oxytocin described above are vagally-mediated.

3. Vagal activation

The other-focus model proposes that the main role of oxytocin is to stimulate the vagus nerve, which is part of the peripheral nervous system. Vagal afferents innervate physiological systems including the facial muscles, eyes, voice, middle ear and heart, systems involved in the experience and expression of emotions, eye-contact, and hearing and speech production (Porges, 1998; Beauchaine, 2001; Heilman, Bal, Bazhenova & Porges, 2007). Activation of the vagus nerve is predicted to initiate other-focused changes in attention, affect and expressivity. Vagal activity promotes other-focused attention by directing gaze toward conspecifics and tuning the bones of the middle ear to the frequency of the human voice, increasing attention to others (Porges, 1998). The vagus is also predicted to increase the experience and expression of positive social emotions through the down-regulation of the sympathetic nervous system and the innervation of facial muscles and vocal cords.

A number of studies have associated high resting vagal tone with social skills and low vagal tone with social deficiencies. High resting vagal tone in male children is positively correlated with teachers' reports of social and prosocial behaviors and negatively correlated with fathers' reports of problem behavior (Eisenberg, Fabes, Murphy, Maszk, Smith & Karbon, 1995). In addition, high resting vagal tone is linked to low levels of aggressive coping and emotionality and high levels of instrumental and support-seeking coping in these children (Eisenberg et al., 1995), indicating that high vagal tone may be related to developing social resources and skills for coping with stress. Adolescents with high vagal tone were also less likely to self-report engaging in aggressive behaviors such as threats or stealing (Mezzacappa et al., 1997). In adults, high resting vagal tone was associated with lower defensiveness and greater behavioral activation, a measure of approach behaviors (Movius & Allen, 2005).

A study of the younger brothers of male teenage delinquents found that low cardiac vagal tone was significantly related to high scores on the Externalizing subscale of the Child Behavior Checklist, a measure of hostility (Pine et al., 1998). The relationship was independent of age, ethnicity, SES or family history of hypertension. Male children diagnosed with conduct disorder and male adolescents similarly diagnosed showed decreased vagal tone relative to non-conduct-disordered, age-matched controls (Beauchaine, Gatzke-Kopp & Mead, 2007). High vagal tone appears to reflect long-term behavioral skills and lack of social dysfunction.

The other-focus model predicts that when the environment is construed as threatening and uncontrollable and others seem unfriendly, other-focus will be suppressed. Individuals suffering from generalized anxiety disorder tend to view the environment and their interaction partners as threatening and uncontrollable (Friedman & Thayer, 1998; Friedman, 2007); anxious individuals should be more likely to be low in markers of other-focus such as vagal activity. In fact, individuals who meet the DSM-IV criteria for generalized anxiety disorder displayed low vagal tone in relation to controls (Thayer, Friedman & Borkovec, 1996). In addition, when individuals were instructed to worry about a topic, vagal tone decreased relative to relaxation (Thayer, Friedman & Borkovec, 1996).

The other-focus model predicts that vagal reactivity during stress signals an other-focused response and more positive outcomes than vagal withdrawal during stress. In support of this, an increase in vagal reactivity in response to an overheard argument was associated with decreased internalization problems in children whose parents were having marital problems (El-Sheikh & Whitson, 2006). The beneficial effects of other-focus in such a situation may include decreased stress and increased social-support-seeking.

Vagal withdrawal during mild to moderate stress may signal a dysfunctional construal of the safety or controllability of the situation, preventing the individual from entering a state of other-focus and benefiting from the stress-buffering effects of that state. In a sample of children showing conduct problems, children who also came from families with a history of domestic violence showed vagal withdrawal in response to peer provocation, possibly reflecting maladaptive hypervigilance (Katz, 2007). Relative to children with few behavioral problems, children at risk for mixed internalizing/externalizing behavioral problems showed vagal withdrawal in response to challenging social and emotional situations (Calkins, Graziano & Keane, 2007), indicating an overactive or underregulated stress response.

Vagal activity is also related to positive emotion. Young children (two to three years old) with high resting vagal tone show greater positive temperamental reactivity and less negative temperamental reactivity in response to emotion-eliciting tasks than children with low resting vagal tone (Calkins, 1997). College students at risk for mania, who scored above the cut-off on the Hypomanic Personality Scale, showed elevated vagal tone across a range of positive, negative and neutral stimuli (Gruber, Johnson, Oveis & Keltner, 2008).

As predicted by the other-focus model, vagal tone at rest and vagal reactivity to a stimulus have been correlated with positive social behaviors, positive emotions and more social coping with stress, while low vagal tone and vagal withdrawal are related to maladaptive social behaviors and hostility. The other-focus model predicts that these relationships are due to the causal effect of vagal activity on attention and emotion, motivating others to attend to conspecifics in their environment in a positive way. Such attention and positive emotion are believed to mediate the relationship between vagal activity and prosocial behavior.

4a. Other-focused attention

The positive effects of vagal activity are believed to be due in part to the influence of vagal activity on attention. It is proposed that when the vagus is active, attention is directed toward others, facilitating empathy, other-focused behaviors and affiliation. When vagal activity is low, social attention is decreased, resulting in decreased opportunities for empathy, fewer other-focused behaviors and generally impoverished interactions with others.

Individuals experiencing increased vagal tone will attend to social cues such as facial expression and vocal tone because both eyelid and middle ear muscles are active, facilitating attention to conspecifics through eye contact and auditory "tuning" to the range of human voice (Porges, 1998). Other-focused attention of this kind increases the likelihood that an individual will also experience empathy (Eisenberg & Fabes, 1990). Social attention may play a role in the phenomenon known as the *chameleon effect*, in which an observer unintentionally mimics the behavior and posture of the observed (Chartrand & Bargh, 1999). Mimicry increases liking in the one mimicked, suggesting that other-focused attention may contribute directly to the accrual of social resources (Chartrand & Bargh, 1999). A prediction of the other-focus model is that, to the extent that attention is a requirement of mimicry, individuals high in other-focus will display more mimicking behaviors in their social interactions.

Many mental disorders are characterized in part by difficulty in social interactions, particularly other-focused attention. These disorders are often accompanied by low vagal tone, while treatments for these disorders often result in heightened vagal tone. For instance, impaired social functioning and a lack of other-focused attention is a hallmark of autism and autism-spectrum disorders. Individuals with an autism-spectrum disorder demonstrate social dysfunctions ranging from the inability to speak or make eye contact to coldness, anger and lack of empathy in their interactions with others (American Psychological Association, 1994). While much about the underlying causes and physiology of autism is unknown, preliminary work suggests vagal dysfunction as a component. An initial study found that children who had been diagnosed with autism showed decreased cardiac vagal tone relative to controls (Ming, Julu, Brimacombe, Connor & Daniels, 2005). In addition, autistic children show increased heart rate (Graveling & Brooke, 1978; Hum, Forrest & Richter, 1975; MacCulloch & Williams, 1971) and heightened sympathetic nervous system activity at baseline compared to controls (Hirstein, Iversen & Ramachandran, 2001), both indicators of decreased vagal activity. Denver (2004) found that autistic individuals showed deficits in vagal tone, eye contact, and the ability to extract human voice from background noise relative to age-matched controls. Low vagal activity at baseline may be a diagnostic characteristic of autism-spectrum disorders.

Evidence that vagal activation motivates other-focused attention comes from work on the treatment of autistic patients with seizures. Vagus nerve stimulation (VNS) was approved by the FDA in 1997 as a treatment for seizures that are unresponsive to pharmaceutical treatment. In VNS, a small pulse generator (about the size of a cigarette lighter) is implanted in the chest. A wire is run up inside the chest to the neck, where it is connected to the left vagus nerve. The device operates much like a pacemaker, firing small electrical impulses that stimulate nerve activity at pre-programmed intervals (Labiner & Ahern, 2007).

VNS has been used to treat the seizures of patients with autism and Asperger syndrome (AS). In addition to treating seizures, VNS appears to have positive impacts on socialization and emotions. In one study, VNS pulse generators were implanted in 59 children (mean age = 12.4 years) who had been diagnosed with autism and intractable seizures (Park, 2003). After three months of VNS therapy, participants showed a 40% median decrease in number of seizures. In addition, the children's physicians reported that 75% of participants showed improvements in general attention to the outside world after three months. After 12 months of VNS therapy, participants showed a 55% median decrease in number of seizures. In addition, 76% of the sample showed improvements in attention, 53% improved in achievement and 61% improved in mood.

A case study of a patient with AS accompanied by frequent seizures also found that six months of VNS treatment resulted in reduced seizure length and frequency, improved verbal skills, social interaction skills and emotionality as reported by the parents and increases in attention, mood and achievement as measured by the physician (Warwick et al., 2007). The findings of these studies are promising in their support for the other-focus model as they demonstrate increases in attention and social functioning due to direct vagal stimulation. The studies do not, however, control for the effects of improvements directly caused by a reduction in the frequency and length of patients' seizures.

The other-focus model predicts that social attention is caused by vagal activity and in turn brings about prosocial behavior. Social attention is related to empathy and possibly to mimicry, increasing the likelihood that individuals will engage in prosocial behavior and be liked by their interaction partners. In addition, autism, a disorder characterized by deficiencies in social skills, is also associated with low vagal tone. Stimulating the vagus to increase vagal tone also increases non-self-directed attention in individuals with autism and AS. It is not known whether the attention measured in the VNS studies was other-focused attention or simply attention to the environments. The other-focus model predicts that the effect in such studies is driven by an increase in other-focused attention.

4b. Positive emotions

Positive emotions play a variety of roles within the other-focus process. Positive emotions may be present initially, when an individual feels safe and secure and interprets another's behavior as receptive to social interactions. Positive emotion may also be initiated by vagal or oxytocinergic activity, both of which are associated with increased positivity (Uvnas-Moberg, 1998; Porges, 1998). Once initiated, positive emotions motivate or reinforce other-focused attention and behavior, perpetuate vagal activity and increase the likelihood of continued positive construal of the environment.

Positive emotions motivate other-focused positive behaviors in a number of ways. Gratitude, for example, motivates other-focused positive behavior both by fostering a desire to reciprocate benefits received and by making the recipient conscious of moral duties and obligations in society (McCullough, Kilpatrick, Emmons & Larson, 2001; Tsang, 2006). Compassion may also be a positive emotion. While it evokes a sense of help needed, which is hedonically negative, it also includes an appraisal that the individual has the capacity to satisfy that need (Ben-Ze'ev, 2000). Compassion, then, may motivate prosocial behavior by making the individual aware of her capacity to assuage a need. Overall, positive emotions appear to elicit other-focus through their capacity to direct attention toward social targets.

Generalized positive affect also promotes prosocial behavior. In multiple studies conducted by Alice Isen and colleagues, participants whose mood had been lifted by small gifts or by finding 10 cents in a payphone were more likely to help others pick up papers, direct individuals with wrong-number telephone calls and willingness to mail a lost letter, among other prosocial tasks (Levin & Isen, 1975; Isen, Clark & Schwartz, 1976; Isen & Levin, 1972). In general, positive emotions due to positive construal of one's environment and personal circumstances lead to increased prosocial behavior (Carlson, Charlin & Miller, 1988).

Positive emotions promote the formation of social bonds. A meta-analytic review of the literature found that across a number of longitudinal studies, high levels of a variety of positive emotions leads to greater relationship satisfaction, higher likelihood of being married and higher likelihood of staying married once wed (Lybomirsky, King & Diener, 2005). College freshmen who characteristically experienced more positive affect reported greater connection to and complex understanding of their college roommates after one month of acquaintance (Waugh & Fredrickson, 2006). Individuals who experience more positive emotions in the workplace receive more social support from supervisor and colleagues (Straw, Sutton & Pelled, 1994). Duchenne laughter, a behavioral signal of positive emotion, evolved to promote affiliation in groups during moments of safety and satiation (Gervais & Wilson, 2005). Positive emotions may increase social support and connection by serving as a signal of receptivity to social interactions and by broadening thought-action repertoires, making affiliative actions more likely (Fredrickson, 1998). Positive emotions promote openness, creativity, decreased self-focus and decreased stress response, making the individual a more attractive and fruitful interaction partner (Fredrickson, 2003).

Due to their pervasive role within the model, a lack of positive emotions should negatively affect all markers of other-focus, from prosocial behavior to vagal activity. Depression is characterized by decreased positive affect and social dysfunction (Watson, Clark & Carey, 1988); depressed individuals should be low in physiological, as well as psychological, markers of other-focus. Participants diagnosed with major depressive disorder showed low resting vagal tone (Rottenberg, Clift, Bolden & Salomon, 2007). Women with mild depression also showed decreased resting vagal tone relative to controls (Light, Kothandapini & Allen, 1998). Women who suffer from premenstrual dysphoric disorder (PMDD) also show lower resting vagal tone during the non-symptomatic follicular phase relative to controls, though this difference is not apparent during the luteal phase (Landen et al., 2004). Persistence of diminished vagal tone across samples differing in depression intensity and symptomology is consistent with the interpretation that the decrease in vagal tone is due to the absence of positive emotion rather than the presence of other symptoms.

Stimulation of the vagus alleviates depression symptoms. VNS therapy was approved by the FDA in 2005 for the treatment of depression that is unresponsive to therapy and pharmaceutical treatment (Groves & Brown, 2005). VNS has been found to stimulate release of serotonin, a mood-enhancing neurotransmitter (Richelson, 2007). In pilot studies and long-term follow up, VNS therapy performed on patients with treatment-resistant depression resulted in a clinically significant improvement in depression (50% reduction in scores on the Hamilton Depression Rating scale) for 30.5% of the sample after 3 months. After one year of continued VNS treatment, 44.1% of the sample showed clinically significant improvement. After two years of treatment, the average HDR score of participants in the sample had decreased from 36.8 to 20.2, indicating clinically significant lasting improvement in depression symptoms (Howland, 2006; Rado & Janicak, 2007).

In the other-focus model, vagal activity promotes positive emotions, but positive emotions also serve as a safety-and-security cue that should promote heightened vagal tone. In fact, some nonpharmacological treatments for depression also cause increases in resting vagal tone. A study of cognitive behavioral therapy (CBT) found increases in vagal tone in the severely depressed group after 16 sessions of CBT (Carney et al., 2000). Vagal tone also increased for depressed individuals receiving acupuncture treatment, but only for individuals who reported decreased depression symptoms over the treatment period (Chambers & Allen, 2002).

The other-focus model predicts that positive emotions work within other-focus in two ways: both as a direct motivator of prosocial, other-focused attention and behavior and as a cue to elicit a moment of other-focus. A number of positive emotions, such as gratitude, promote other-focused behavior. In addition, manic individuals show heightened resting vagal tone, while depressed individuals lacking in positive emotions showed low resting vagal tone (indicating the absence of an other-focused orientation), and recovery from depression was characterized by increases in vagal tone. These findings are consistent with the predictions of the other-focus model regarding the ability of positive emotions to spur prosocial behavior and promote other-focused physiological states.

5. Positive other-focused behavior

Other-focused attention and positive affect increase the likelihood that the individual will engage in other-focused behavior and thereby build relationships. For example, increased attention to others' social cues permits more accurate responses to those cues, which in turn is related to increased positive emotional responses from the other. In one study of gift-giving, sorority members who appraised their sorority sisters' gifts as more thoughtful and personalized showed more gratitude toward, and spent more time with, the gift-giver than sorority members who received less personally appropriate gifts (Algoe, Haidt & Gable, 2008). This attention would also be critical in a parent/child relationship where the parent must be able to identify and motivated to satisfy the child's needs if the child is to thrive, or even live to adulthood (Mikulincer & Shaver, 2007; Taylor et al., 2000).

An individual is also motivated to satisfy the needs she observes because of an increased capacity for empathy. Empathy inductions increase cooperative responses in a Prisoner's Dilemma Game task, a task where the choice to cooperate helps one's partner but entails some personal risk (Batson & Moran, 1999). The influence of empathy on prosocial behavior begins early in life; relative to low-empathy kindergarten and first-grade students, the mothers of high-empathy students reported that their child engaged in more prosocial behavior (more wiling to invite other students to join a game) and less aggression (fights with other children) (Findlay, Girardi & Coplan, 2006).

The way that an individual interprets another's need for prosocial assistance influences the extent that he will experience other-focus and act to help (Loewenstein & Small, 2007). Empathy increases the likelihood that an individual will interpret the other's situation as deserving of help by promoting a shared emotional experience and increased perspective-taking. Empathy-inducing instructions, which encourage perspective-taking and attention to others' needs, generate unique patterns of brain activity as measured by fMRI, patterns that were distinct from those that occurred when a person simply observed another in distress (Lamm, Batson & Decety, 2007). Other-focus thus results in more generous interpretations of others' needs and a greater motivation to behave prosocially through the mechanism of empathy.

In addition to being more likely to act in an other-focused manner, an individual who is experiencing an other-focused moment may also be the target of other-focused behavior from others. Positive emotions, like all emotions, can be shared among individuals in a group or dyad through emotion contagion (Hatfield, Cacioppo & Rapson, 1993). Positive emotions also spark positive meaning in others, leading those others to also experience positive emotions (Fredrickson, 2003). Individuals who express positive emotions in face and voice (especially through laughter; Gervais & Wilson, 2005) are more likely to elicit positive emotions, and possibly other-focus, in others. These mutual positive interactions lay the groundwork for social bonds (Brown & Brown, 2006; Cohn & Fredrickson, 2006). These bonds can result in activities such as the exchange of social support or other, more tangible resources.

In the other-focus model, an individual's positive other-focused attention and positive affect are predicted to cause the individual to behave prosocially. Empathetic individuals, who attend to the cues and emotions of others, act more prosocially in a number of different contexts. Individuals experiencing positive emotions also are more likely to help others. Positive emotions in the self may also encourage prosocial behavior from others by building relationships and encouraging positive interpersonal interactions. These effects support the predictions of the other-focus model that positive social attention and affect have beneficial effects on the behavior of self and others.

6. Long-term benefits

Frequent other-focused moments result in enhanced physical and psychological well-being because these moments help to decrease stress and build social resources that the individual can utilize at a later date. A review by Uchino, Cacioppo and Kiecolt-Glaser (1996) found that social support was positively related to a number of indices of physical health, including cardiovascular and immune health. These benefits could not be accounted for by self-reported health-related behaviors, but the stress-buffering effects of family and social support played large roles. Lack of social contact also increases mortality risk following acute myocardial infarction (Ruberman, Weinblatt, Goldberg & Chaudhary, 1984; Case, Moss, Case, McDermot & Eberly, 1992; Berkman, Leo-Summers & Horwitz, 1992).

Positive emotions, a significant component of other-focus, are also linked to positive outcomes for health. High levels of trait positive affect are linked to longevity, while low-arousal state positive affect is related to decreased reports of symptoms and pain across a wide range of studies (Pressman & Cohen, 2005). Positive emotions may also protect the body from disease. In a sample of over 1,000 patients, individuals high in hope or curiosity were less likely to develop hypertension or diabetes over the next two years (Richman et al., 2005). By eliciting positive emotions, other-focus has consequential positive effects for health.

Other-focus may also promote health by motivating individuals to give social support. Across 423 older married couples, adults who reported giving instrumental and emotional support to others showed decreased mortality across the 5-years of the study (Brown, Nesse, Vinokur & Smith, 2003). The beneficial effect of giving social support could not be accounted for by the benefits of social contact alone. Acting prosocially uniquely contributed to the longevity of individuals in the study, an exciting finding that supports the conceptualization of other-focus as a beneficial state for self as well as for others.

Because other-focus is an element of some psychological well-being measures (e.g. Ryff & Keyes, 1995), it is difficult to locate empirical research that teases apart psychological health from the tendency to engage in other-focused behavior. Extraversion, a measure of gregariousness and outward-focused attention as measured by the NEO-PI, was positively correlated with several measures of mental health: Life satisfaction across multiple life domains (health, money, neighborhood, etc.), the one-item Delightful-Terrible scale (Andrews & Withey, 1974) and trait positive affectivity (McCrae & Costa, 1991). High school students' self-reported social interest, an index of investment in social groups, was positively correlated with life satisfaction in a sample of 321 adolescents (Gilman, 2001). Individuals who experience more positive emotions, a component of other-focus, are more socially engaged and report a lower incidence of psychopathology (Diener & Seligman, 2002). Other-focus may promote psychological health by increasing the availability of social resources to help the individual cope with stress and lessening the likelihood of social ostracism, an extremely aversive state. Other-focus also increases the likelihood of positive interactions with others, a contributing factor in many measures of well-being (Keyes, 2002).

Individuals who are aware of the needs of others, and who are also motivated to fulfill those needs, increase the likelihood of survival for all members of the group. Individuals who experience more positive emotions and who consequently think more broadly and flexibly (Isen, Daubman & Nowicki, 1987; Fredrickson, 2001; Fredrickson & Branigan, 2005), will be better able to generate creative ways of solving social problems, thus promoting harmony within the group. Social sensitivity may also be related to status in the group. In many cultures, it is the responsibility of high ranking members of a group to care for the young or needy by sharing resources and providing protection (e.g. Ryff & Singer, 1998). Stable, healthy groups contribute to the longevity and well-being of all group members by facilitating resource sharing while minimizing stress and process loss.

From an evolutionary perspective, ancestral humans with a propensity to experience moments of other-focus may have been more likely to experience reproductive success. The other-focus model predicts that individuals who show signs of other-focus such as other-directed attention and prosocial behavior will be more attractive as mates. Other-focus increases the probability of raising successful offspring and builds up a store of resources for survival under adverse circumstances, increasing the likelihood that other-focused individuals will be successful reproductive agents. As social resources accumulate, individuals are better able to cope with stress and construe a wider variety of situations as controllable and safe, thus potentiating further other-focused moments. In addition, social resources cushion the effects of stress and misfortune, reducing the health impacts of negative events. Thus, over time, individuals who experience more moments of other-focus will experience lives of increased well-being and longevity.

Summary

The other-focus model combines insights from psychophysiological and social psychological work that explores why people make the sometimes costly but essential choice to affiliate with and invest in others. Other-focus begins when the environment is construed as safe, secure and controllable. Empirical work finds that oxytocin is related to other-focused behavior, positive emotions, social contact and coping with stress, and may also promote vagal activity in humans, although more investigation of this point is needed. High baseline vagal tone is related to positive emotions and other-focused attention and behavior, as well as beneficial long-term health outcomes, in child, adolescent and adult samples, while low baseline vagal tone is related to negative behavioral outcomes, social dysfunction and affective disorders. Over time, other-focus results in improved physical and mental health.

Further work must be conducted, however, to explore the temporal structure of other-focus and to separate proximal and distal psychological effects of physiological causes. For instance, it is unknown whether the relationship between trait vagal activity and other-focused behavior is mediated by other-focused attention, as predicted by the model. In addition, while considerable evidence exists that low baseline vagal tone is associated with negative emotional states such as anxiety and depression, further work is necessary to clarify the relationship of baseline vagal tone and vagal reactivity with positive emotions. This is particularly important given that positive emotions are not simple opposites of negative emotions (Fredrickson, 1998).

Much of the work reviewed has focused on trait-level rather than state-level factors. The other-focus model also makes specific predictions regarding the direct affective, cognitive and behavioral effects of momentary increases in other-focus. In order to understand how trait other-focus brings about well-being, it is vital to understand what occurs within an other-focused moment. The other-focus model predicts that the small, subtle effects of physiological and psychological events that take place as part of a momentary other-focus process will accumulate and compound over time, resulting in long-term changes in an individual's well-being.

Chapter 3

Analyses

The purpose of this research is to investigate the predictions of the other-focus model with regard to *1)* the relationship of vagal activity to other-focused attention, positive emotions and behavior and 2) factors that elicit vagal reactivity and *3)* the consequences of high vagal tone for social resources and well-being.

The studies analyzed below comprise three sources of archival data collected by the Fredrickson lab over the last seven years. The archival data sets were selected because all have measures of baseline RSA recorded using a modified Grossman (1983) method (described in the section "Measuring Vagal Activity," below).

Because these datasets are archival, the analyses I conduct are largely correlational in nature. In lieu of testing specific paths within the other-focus model, I explore relationships in the data that are anticipated by the model. Such exploration cannot confirm the validity of the model, but it does provide initial support for the socio-psychophysiological perspective on other-focus described above.

All data sets contain information concerning the relationship between baseline vagal tone and various measures of other-focused attention, positive emotions, other-focused behavior and social resources. In addition, some data sets contain measures of vagal reactivity during stress or during various social activities. For each individual study, I describe the characteristics of the sample, the study procedure, and the hypotheses of the other-focus model that are tested.

Measuring Vagal Activity: Respiratory Sinus Arrhythmia

Vagal activity can be considered in two ways: a person's characteristic, or trait, level of vagal activity, and vagal reactivity in response to a particular situation. Characteristic levels of vagal activity are hypothesized to reflect a person's self-reported traits, particularly traits relating to social resources, relationships, communication and orientation toward new social experiences. Vagal reactivity in the moment should mediate an individual's physical and emotional responses to various environmental stimuli.

Vagal activity and reactivity are measured through respiratory sinus arrhythmia (RSA). The role of the vagus is to serve as a cardiac "brake," slowing a mammal's naturally high heart rate in order to increase cardiac efficiency (Berntson et al., 1997). This "vagal brake" slows heart rate during expiration, a period when there is no need to circulate blood quickly through the lungs. The brake releases and heart rate is allowed to speed up during inspiration, increasing the amount of blood that is oxygenated during one breath. RSA is an index of this finely-tuned cardiorespiratory relationship. It is measured as the average difference between the minimum cardiac interbeat interval during inspiration and the maximum cardiac interbeat interval during expiration over a period of time.

In the following studies, RSA is used as a measure of vagal activity at both the trait and state levels. Baseline RSA measurement consists of heart rate and respiration recorded in conjunction for a period of two minutes, during which the participant is at rest. The participant is asked to relax and breathe normally, as, in the absence of physical movement, RSA appears to be unaffected by frequency of respiration (Denver, Reed &

Porges, 2007). RSA during activity is measured for the duration of the activity, and the participant is again not given any instructions concerning respiration.

Before beginning analyses, data quality thresholds were set in order to ensure that RSA data reflected vagal tone rather than error. High impedance, or interference in a sensor, increases random error in measurement of vagal tone. Participants were excluded if impedance in the heart rate sensors rose above 80 Hz. In addition, RSA outliers over 6 standard deviations above the mean were excluded. The number of participants excluded by this cleaning protocol will be reported at the beginning of the results for each study.

Study 1

The original purpose of Study 1 was to investigate the effects of induced emotions on cognitive broadening. Participants' emotional and physiological responses to five emotion inductions varying in affect and arousal level were recorded. Using these data, I explored factors that elicit vagal reactivity in the moment: cues of controllability in the environment, in this case low-arousal emotions. I also explored whether extraverts, individuals high in other-focused traits of gregariousness and positive emotionality, exhibit greater vagal reactivity to other-focus eliciting cues.

Participants

The Study 1 dataset contains data from 133 undergraduate students (mean age = 20.5, 56% female) recruited at a large Midwestern university.

Procedure

Participants entered the lab and were assigned to one of five conditions. In each condition, participants engaged in a relived-emotion task where they were asked to remember a moment when they had felt a specific emotion: Contentment (low-activation positive emotion), amusement (high-activation positive emotion), sadness (low-activation negative emotion), fear (high-activation negative emotion) or no emotion. Participants then watched a film intended to induce that emotion. Immediately after the emotion-inducing film, participants were asked to vividly re-experience the emotions they had felt during their memory, using the emotion induced by the video to enhance the intensity of their emotional memory. RSA was recorded at baseline and during the emotion induction video and memory session for each participant. In addition to watching the videos, participants completed a number of trait measures, of which only the Extraversion scale of the Five Factor Inventory (NEO-FFI; Costa & McCrae, 1992) will be discussed here.

Hypothesis

Individuals high in extraversion (an indicator of gregariousness and psychological health; McCrae & Costa, 1991) will show greater vagal reactivity to the low-arousal videos (sadness, contentment, neutral) than individuals low in extraversion. Vagal reactivity will not be correlated with extraversion in the high-arousal (anger, amusement) video conditions.

Results

Two participants were excluded due to impedances over 80, an additional 14 were excluded due to mean RSA values six standard deviations above the sample mean in either baseline or reactivity measurement periods, leaving a sample of N = 118.

A prediction of the other-focus model is that vagal reactivity will be elicited by cues for safety and security, such as low arousal, and that characteristically other-focused individuals will be most reactive to such cues. Vagal activity at baseline and vagal reactivity are highly correlated ($r = 0.79$, $p < .001$ for the emotion inducing film, $r = 0.71$, p < .001 for the emotional recall task). To ensure that findings reflect vagal reactivity to the stimulus rather than baseline vagal activity, vagal reactivity was computed as the residual variance in RSA during the emotion inductions or memory period that was not accounted for by baseline RSA levels.

Because the other-focus model predicts that feelings of safety, security and controllability elicit other-focus, RSA data from the contentment, sadness and neutral conditions, which are high in controllability, was combined to represent vagal reactivity to low arousal stimuli, while RSA data from the amusement and anger conditions, which are low in controllability, was combined to represent vagal reactivity to high arousal stimuli.[2]

For the low-arousal videos, extraversion was positively correlated with vagal reactivity during both the emotion-inducing films (r = 0.35, p < .001) and the emotional memory recall task (r = 0.38, p = 0.001). Extraversion was not correlated with vagal reactivity to the high-arousal videos (r = 0.00, p = 0.997) or the high-arousal emotional recall task (r = .00, p = 0.996). Extraversion was not significantly related to vagal activity at baseline (r = 0.04, p = 0.668).

Discussion

Extraversion is a trait reflecting gregariousness and psychological health, both characteristics typical of individuals who are frequently other-focused. In this sample, individuals high in extraversion were more vagally reactive to low-arousal emotional stimuli that may serve as cues of the controllability of the individual's environment.

[2] Individual correlations for low-arousal conditions: Contementment r = 0.33, p = 0.091 for film, r = 0.46, p = 0.015 for memory; Sadness r = 0.52, p = 0.013 for film, r = 0.354, p = 0.106 for memory; Neutral r = 0.58, p = 0.009 for film, r = 0.378, p = 0.111 for memory.
Individual correlations for high-arousal conditions: Amusement r = -0.04, p = 0.865 for film, r = 0.07, p = 0.739 for memory; Anger r = 0.06, p = 0.800 for film, r = -0.08, p = 0.707 for film.

Individuals high in extraversion were not more vagally reactive to high-arousal emotional stimuli (amusement and anger), which are associated with a lack of controllability in the environment. The positive emotionality and gregariousness that characterize extraverts may result from a tendency to be more responsive to environmental cues that initiate high vagal reactivity, a physiological state that is a potential motivator of other-focus.

Study 2

The dataset in Study 2 was collected to investigate the relationship between positive emotions and processing of other race faces. Because this dataset is explicitly concerned with measuring social connectedness and broadened social groups, it contained several measures of prosocial orientation and social support, in addition to baseline vagal tone. In this dataset I investigated whether concern and care for others, an element of other-focus, was associated with high baseline vagal tone.

Participants

152 students enrolled at a southeastern university, recruited from the psychology participant pool.

Procedure

Participants entered the lab and completed the Self-Importance of Moral Identity scale (SIMI; Aquino & Reed, 2002). The SIMI is a scale intended to measure the extent to which the individual values the following characteristics in herself: Caring, compassionate, fair, friendly, generous, helpful, hardworking, honest, and kind. These traits were the result of a series of studies in which participants were asked to list the characteristics they felt described a moral person (Aquino & Reed, 2002). The measure has two subscales: Internalization, which measures the degree that moral traits play a central role in the individual's self-concept, and Symbolization, which reflects the extent that the individual self-presents as caring and moral. The Internalization score of the SIMI scale was related to perceived moral obligations toward outgroups (Reed & Aquino, 2003). Baseline RSA was also recorded as described in Study 1. Other tasks followed, but are not related to the intent of these analyses and so will not be reported here.

Hypothesis

Baseline vagal tone will correlate positively with the Internalization subscale of the Self-Importance of Moral Identity measure. The other-focus model predicts that individuals high in baseline vagal tone will be more likely to engage in positive social attention and prosocial behavior; high scores on the Internalization subscale of the SIMI may serve as an initial, proxy measure of prosocial attention and behavior toward others, particularly outgroups. The Symbolization subscale represents the individual's self-focused desire to appear moral and caring, and thus will not be related to baseline vagal tone.

Results

Thirty-eight participants were excluded due to impedances over 80. Thirteen additional participants were excluded due to RSA values six standard deviations above the sample mean, leaving a sample of N = 101. Vagal tone at baseline was significantly correlated with individuals' trait levels of Internalization ($r = 0.29$, $p = .004$) and uncorrelated with Symbolization ($r = -0.18$, $p = 0.075$).

Discussion

The Internalization subscale of the SIMI represents the degree to which an individual wants to see himself as a moral person. In this sample, baseline vagal tone was positively correlated with Internalization, suggesting a relationship between a person's characteristic level of prosocial interest in others and baseline physiological state. Baseline vagal tone was not related to Symbolization, suggesting that it is the individual's investment in and care for others, and not their desire to self-present as moral, that is related to baseline vagal activity.

Study 3

The purpose of Study 3 was to investigate the psychological and physical effects of lovingkindness meditation (LKM). LKM is of interest psychologically as an inducer of social connectedness (Hutcherson, Seppala & Gross, 2008) and positive emotions (Fredrickson, Cohn, Coffey, Pek & Finkel, in press). These data consist of beginning and end-of-study measures of vagal tone and nine weeks of daily emotion and behavior reports as half the sample is trained in LKM. I will be able to investigate the predictions of the other-focus model regarding the effects of vagal tone on positive emotions and social behavior, using an adult age group.

The Study 3 dataset contains measures of progesterone taken at the same time at the end-of-study measure of vagal tone. Progesterone and oxytocin have been found to be released concomitantly in bovines (Miyamoto & Schams, 1991), and progesterone has been linked to affiliative urges in humans (Schultheiss, Wirth & Stanton, 2004). Because of the difficulty in measuring oxytocin in humans and the archival nature of the analyses presented here, I utilize progesterone as an initial approximation for oxytocin in these preliminary explorations of the relationship between vagal activity and OT.

This dataset also provides the opportunity to study changes vagal tone over time in response to environmental factors: in this case, a persistent social connectedness and positive emotion induction. While attachment theory posits that the tendency to experience other-focus is influenced by experiences in infancy, little work has investigated the degree to which the tendency to experience the physiological and psychological elements of other-focus may be shaped by experience in adults (for an example of such research, see Hutcherson, Seppala & Gross, 2008).

Participants

Faculty and staff at a large southeastern university responded to recruitment flyers put in their mailboxes. 73 participants (mean age =39, 66% female) completed all stages of the study.

Procedure

Lovingkindness meditation (LKM) is a form of meditation where participants are encouraged to cultivate warm, loving feelings toward themselves, their friends and family, and finally toward all beings, working outward as the meditation sessions progress (Salzberg, 2002). Half of the participants were assigned to a waitlist control condition, while the other half received training in LKM.

Participants first participated in an initial lab session where a two-minute RSA baseline was recorded using the procedure described in Study 1.

A few days after the initial laboratory session, participants began completing short online daily reports, which they completed each day for nine weeks (63 days). These reports included a daily emotions report (mDES; Fredrickson, Tugade, Waugh, & Larkin, 2003) and ratings of the quality of the three longest social interactions they had participated in that day. In the mDES, participants were asked to report the extent that they had experienced each of 10 positive and 10 negative emotions during that day, using a scale from 0 ("Not at all") to 4 ("Very much so"). The scores for the 10 positive emotion items were averaged to create a composite daily Positive Emotion (PE) score with an alpha coefficient of 0.94.

Participants reported the extent that they were other-focused in their daily social interactions by rating how close and in-tune they felt with their interaction partners during their three longest social interactions that day. Participants answered the following questions: "During the social interaction, I felt "in tune" with the person/s around me" and "During the social interaction, I felt close with the person/s around me." Responses fell on a 1 to 7 point scale from "Not at all" to "Very much so." The "Closeness" and "In Tune" questions were highly correlated ($r = 0.89$, $p < .001$) and were summed to create a Positive Social Attunement (PSA) variable with a range from 1 to 14. The daily PSA score represents a participant's degree of other-focus during each day.

One week after the first daily report, participants were randomly assigned into either a six week meditation workshop, or a wait-list control group. Those assigned to the meditation workshop attended six weekly workshop sessions and were encouraged to begin a meditation practice using guided meditations on CD.

At the end of the nine week study period, participants returned to the lab for a second laboratory visit to assess their cognitive and physiological responsiveness to

LKM. Participants provided a saliva sample that was used to obtain baseline progesterone levels and recorded a second RSA baseline.

Hypotheses

1) Baseline vagal tone upon entering the study will predict positive emotions and the extent of other-focused attention in the daily reports. 2) Relative to participants in the waitlist-control condition, participants in the meditation condition will show increases in baseline vagal tone from the beginning to the end of the study. 3) Progesterone, a hormone implicated in affiliation motivation (Schultheiss, Wirth & Stanton, 2004), will be positively correlated with vagal tone.

Results

One participant was excluded due to impedances over 80. An additional four were excluded due to mean RSA values six standard deviations above the sample mean at baseline. Three participants were excluded due to missing RSA data, leaving a total sample of N = 65. Table 2 gives the means and standard deviations by condition for the variables analyzed.

Hypothesis 1a: Effects of baseline vagal tone on daily other-focus

The other-focus model states that vagal tone at baseline should predict the extent that participants' daily interactions were other-focused. In order to test this hypothesis, a hierarchical linear model was fitted to the data using the statistical program STATA (StataCorp, 2007). Baseline vagal tone, time spent meditating, time, study condition, gender and two-and-three-way interactions between baseline vagal tone, time spent meditating and time were included as predictors of Positive Social Attunement (PSA). Table 3 presents the results.

The “time” predictor was significant and positive, indicating that all participants showed increases in other-focus over time. There were no other direct effects in the model. The interaction between vagal tone and time was significant and positive. Individuals who entered the study with high vagal tone (RSA) showed greater increases in other-focus over time than participants with low vagal tone. The interaction between vagal tone and time spent meditating was also positive. Individuals high in vagal tone who spent more time each day engaged in Lovingkindness Meditation showed greater increases in other-focus from their meditation practice. Finally, the significant and negative three-way interaction of time spent meditating, time and baseline vagal tone suggests that the beneficial effects of LKM and high vagal tone on PSA decrease in magnitude when both time spent meditating and RSA are high. Figure 2 shows these relationships.

I explored the three-way interaction using the Johnson-Newman regions of significance technique for probing three-way interactions in HLM devised by Bauer and Curran (2005). Values were calculated and figures were generated using an online calculator developed by Preacher, Curran and Bauer (2006). The regions of significance technique provides the range of values of one variable in the three-way interaction (here RSA) that will result in significant simple slope estimates when values of a second variable in the interaction (here time spent meditating) are held constant at various levels. In these analyses, time spent meditating is set at an average of 2.04 minutes per day (the average for participants in the non-meditating condition), 12.45 minutes per day (the average for participants in the meditation condition), and 20.04 minutes per day (one standard deviation above the average for people in the meditation condition).

For non-meditators, the conditional effect of RSA on other-focus was significant and positive for values of RSA between 0.062 (less than 1 sd below mean RSA) and 0.153 (approx 2 sd above mean). For meditators who spent an average amount of time meditating, the conditional effect of RSA on other-focus was significant and positive for values of RSA between 0.051 (less than 1 sd below mean) and 0.135 (approx 1 sd above mean). For high amounts of time spent meditating, the conditional effect of RSA is significant for values of RSA between 0.025 (2 sd below mean RSA) and 0.119 (less than 1 sd above mean RSA). Figure 3 shows the regions of significance for the three levels of time spent meditating. The breakdown suggests that when an individual is high in both time spent in LKM and RSA, the effects of being high in both together is similar to the effect of being high in one or the other alone, such that after controlling for high levels of time spent meditating, the effect of a high level of RSA over time on PSA becomes non-significant.

Hypothesis 1b: Effects of baseline vagal tone on daily positive emotions

The other-focus model states that vagal tone at baseline should predict participants' daily positive emotions. In order to test this hypothesis, a hierarchical linear model was fitted to the data using the statistical program STATA (StataCorp, 2007). Baseline vagal tone upon entering the study, time spent meditating, time, study condition, gender and two-and-three-way interactions between baseline vagal tone, time spent meditating and time were included as predictors of daily Positive Emotions (PE). Table 3 presents the results.

The "time" predictor was significant and positive, indicating that all participants showed increases in positive emotions over time. "Time spent meditating" was also significant and positive, indicating that, on average, engaging in LKM significantly increased positive emotions. There were no other direct effects.

The interaction between RSA and time was significant and positive. Individuals who entered the study with high vagal tone (RSA) showed more growth in positive emotions over time than participants with low vagal tone. The interaction between RSA and time spent meditating was also significant and positive. Individuals high in vagal tone who spent more time each day engaged in LKM showed greater growth in positive emotions from their meditation practice. The significant and negative three-way interaction of time spent meditating, time and baseline vagal tone suggests that the beneficial effects of LKM and high vagal tone on daily PE decrease in magnitude when both time spent meditating and RSA are high. Figure 4 shows these relationships.

A Johnson-Newman exploration of the three-way interaction reveals that for non-meditators, the conditional effect of RSA on positive emotions was significant and positive for all values over 0.066 (less than 1 sd below mean RSA). For meditators who spent an average amount of time meditating (12.46 minutes per day), the conditional effect of RSA on positive emotions was significant and positive for values over 0.050 (approximately 1 sd below mean RSA). For high levels of time spent meditating (20.04 minutes per day, 1 sd above mean time spent meditating), however, the conditional effect of RSA and positive emotions was significant only between 0.055 (approximately 1 sd below mean RSA) and 0.108 (less than 1 sd above mean RSA). Figure 5 shows the regions of significance for the three levels of time spent meditating. The breakdown suggests that when an individual is high in both time spent in LKM and RSA, the effects of being high in both together is close to the effect of being high in one or the other alone, such that after controlling for high levels of time spent meditating, the effect of a high level of RSA over time on daily PE becomes non-significant.

Because vagal tone appears to influence other-focus and positive emotions in a similar way, I tested whether the relationship between vagal tone and other-focus might be due to changes in positive emotion or vice versa. When daily positive emotions are added to the other-focus model, the positive emotion coefficient is significant and positive (1.83, $p < 0.001$), but none of the other predictors change in significance. Similarly, when daily other-focus is added to the positive emotions model, the other-focus coefficient is significant and positive (0.127, $p < .001$), but the effects of vagal tone and time spent meditating remain largely significant, with only the interaction between time spent meditating and RSA made marginal ($p = 0.06$). This indicates that the effect of vagal tone on daily other-focus is not mediated by daily positive emotions, nor is the effect of vagal tone on daily positive emotions mediated by daily other-focus, though each significantly predicts the other.

Neither vagal tone at baseline nor time spent in LKM influenced participants' reports of negative emotions. Vagal tone at baseline upon entering the study was not significantly correlated with Day 1 PE or Day 1 PSA, measures of positive emotions and positive social attunement before beginning LKM.

Hypothesis 2: Effects of LKM on RSA

Lovingkindness Meditation directs peoples' positive attention to those around them and (as found in the previous models) increases reports of other-focus in daily interactions. I tested whether six weeks of practicing LKM might increase baseline vagal tone, reflecting the influence of behavior (in this case, an increased tendency to positive social attention) on physiology. Meditators showed increases in baseline vagal tone (mean change= 0.01, sd = 0.03), while the vagal tone of non-meditators decreased (mean change= -0.01, sd = 0.03). The difference in change between the two conditions was significant (one-tailed $t(50)= 1.761$, $p = 0.04$). Within-participant changes in RSA from time 1 (before beginning meditation) to time 2 (after nine weeks) were marginally significant for meditators (one-tailed $t(50) = 1.344$, $p = 0.09$) and non-significant for non-meditators (one-tailed $t(50)= -1.147$, $p = 0.13$).

Hypothesis 3: Other-focus and progesterone

Progesterone data were collected during the second lab session. Three participants were dropped in the progesterone data, one due to outliers (progesterone values 10 times as high as other participants) and two due to missing data. At the last lab session of the study, 13 participants did not record baseline vagal tone, and an additional two were dropped due to impedances over 80. In total, data were analyzed from 52 participants.

Progesterone has been theorized to serve an affiliation function in males and females (Schultheiss et al., 2004). I tested whether end-of-study baseline progesterone levels were correlated with end-of-study baseline vagal tone for meditators, non-meditators or both. Because progesterone may act differently in males and females (Evans, 2007), results were divided by gender as well as condition. Analyses for women were further subdivided based on use of hormonal birth control. No differences emerged in progesterone levels between the women using hormonal birth control (the pill, the patch or the ring) and women not using hormonal birth control; further analyses utilize the entire female sample.

Splitting the analyses by gender, men (N = 18) showed a marginally significant positive correlation between baseline vagal tone and baseline progesterone levels (r = 0.45, p = 0.06). Women (N = 32) did not show a significant relationship (r = 0.13, p = 0.46).

Splitting by study condition, meditators (N = 23) showed a significant positive correlation between baseline vagal tone and baseline progesterone (r = 0.46, p = 0.01). Non-meditators (N = 27) did not show a significant relationship (r = -0.06, p = 0.79).

The data were then split into four groups to determine whether there was an interaction between LKM practice and gender. For male non-meditators, the correlation between vagal tone and progesterone was high and non-significant (r = 0.46, p = 0.29), but the lack of significance may be due to the small sample size (N = 7). For female non-meditators (N = 16), the correlation was not significant (females r = -0.21, p = 0.45). Male meditators (N = 11) showed a significant vagal tone/progesterone correlation (r = 0.67, p = 0.02), while for female meditators (N = 16) the correlation was high but not significant (r = 0.422, p = 0.10), again potentially due to the small sample size for that subgroup. Given the small sample sizes for the various subgroups in this analysis, it is difficult to interpret these findings.

Discussion

The other-focus model predicts that activity of the vagus nerve will result in increases in other-focused positive attention and positive emotions. In this study, baseline vagal tone positively predicted participants' positive social attention and positive emotions over a period of 63 days. Individuals high in baseline vagal tone experienced their days and interactions differently than individuals low in baseline vagal tone. The effects of vagal tone on other-focused attention were not mediated by positive emotions or vice versa, suggesting that, as predicted by the other-focus model, the vagus acts on emotions and attention, and it does so in distinct ways. As shown in Figures 2 and 3, high baseline vagal tone led participants to perceive themselves as increasingly closer and more in-tune with their interaction partners during their daily interactions, and also to experience more positive emotions throughout their day.

Progesterone data from this sample was used as a proxy for oxytocin in order to test the hypothesized association between affiliation hormones and vagal tone in the model. It was found that progesterone and baseline vagal tone were significantly associated for men and for meditators, though it was unclear whether the effect was due to an interaction between gender and meditation condition or a main effect for one of the grouping variables. Despite this ambiguity and the lack of information concerning the causal direction of the relationship, the fact that an association may exist between affiliation hormones and vagal tone is encouraging.

As demonstrated by the two statistical models, LKM causes the individual to experience more positive emotions and positive social attention each day, in a manner that is similar to the effects of baseline vagal tone. The other-focus model predicts that, over time, increased positive social attention and positive emotion will increase vagal tone, leading to an upward spiral of other-focus and accrued social resources. In this sample, individuals who engaged in LKM showed a marginally significant increase in baseline vagal tone. Given the target of change (a trait-level physiological variable), the time elapsed (three months), and the small sample size ($N = 50$), this marginal increase is suggestive initial evidence for the upward spiral element of the other-focus model.

Chapter 4

General Discussion

According to the other-focus model described here, the activity of the vagus nerve, either at rest or during activity, reflects a predisposition toward other-focus and responsiveness to positive social stimuli that allows the individual to capitalize on social interactions and pursue and build relationships, growing in other-focus and positive emotions over time. The model received preliminary support from archival analyses of three datasets. In Study 1, individuals high in extraversion were more vagally reactive to low-arousal stimuli in the form of videos and memory recall, suggesting that psychologically healthy individuals such as extraverts not only act and react differently to certain stimuli on a psychological level, but that they also are more physiologically responsive to cues of situational safety and controllability. Perhaps extraverts' characteristically high levels of positive emotionality and gregariousness can be attributed in part to a greater sensitivity to cues that may initiate an other-focused state.

Similarly, in Study 2 individuals who valued and placed a priority on being a moral person showed higher baseline vagal tone. The other-focus model predicts that morally engaged, prosocial individuals will approach the world physiologically prepared to engage in social interactions, open and attuned to the signals of the individuals around them. The correlation between vagal tone and valuing a moral identity is congruent with this prediction.

Beyond momentary, slice-of-life assessments, Study 3 was able to track the behaviors and reactions of individuals high in baseline vagal tone over the course of nine weeks. High vagal tone at baseline predicted greater growth in other-focus and positive emotions over time, as measured by individuals' reports of their emotions and ratings of their social interactions each day. In addition, individuals with high vagal tone were able to capitalize on the practice of LKM, showing greater increases in other-focus and positive emotion per hour spent meditating than individuals low in vagal tone. As time passed and individuals spent more time meditating, the benefits of high baseline vagal tone decreased, suggesting that vagal tone served as an initial boost to participants learning LKM for the first time. The positive, open, other-focused thinking fostered by LKM may have been familiar to individuals with high baseline vagal tone.

Lovingkindness Meditation promotes a practice of positive other-focused attention that may resemble the orientation and perspective of individuals high in vagal tone. From the beginning to the end of the study, meditators increased in baseline vagal tone, while non-meditators decreased. By promoting positive emotions and other-focus, LKM also influenced individuals' physiological state, in this case increasing baseline vagal tone. This effect, though only marginally significant, gives the first hints of a potential upward spiral of other-focus, in which high vagal tone promotes other-focused attention and behavior, which in turn increases feelings of safety and attention to conspecifics, which leads to increases in resting vagal tone and so on. Further analyses that utilize a larger sample or extend over a longer time period would be necessary to explore the possibility of this hypothesized upward spiral.

Also in Study 3, baseline progesterone and baseline vagal tone were positively associated for males and meditators. Given the role of progesterone in promoting affiliation-motivation (Schultheiss et al., 2004), the association with vagal tone provides further evidence that the vagus is implicated in promoting affiliation and other-focus. Further work is necessary to determine how vagal tone and progesterone are related. Potentially, just as epinephrine serves to activate the sympathetic nervous system to ready the body for defensive actions, progesterone may promote activity in the PNS, including the vagus, which in turn leads to other-focused attention and behavior.

Limitations

One significant limitation across all studies is that many measures were based on self-report. In particular, measures of morality and sociability are vulnerable to social desirability effects. The measures in studies 1 and 2, then, may be less reliable than the daily reports in study 3, which, though still composed of self-reports , ask participants to describe experiences they have had during the day and thus can be considered a report of behaviors rather than a global evaluation of the participant's disposition.

An additional limitation of these analyses is that they are based on archival data. Even after statistically controlling for undesired factors, sources of irrelevant variability have the potential to obscure relations of interest among the variables. In particular, the inductions used in Study 1 were intended to manipulate emotion, rather than other-focused construals per se. Further studies will be able to investigate the specific effects of particular environmental construals on vagal reactivity.

In addition, the archival nature of data sometimes resulted in low power, making certain tests difficult to interpret. In particular, the findings regarding progesterone could have benefited from an additional 20 participants per cell in order to enhance the statistical power of the correlations computed.

The retrospective reports in Study 3 make that data vulnerable to retrieval biases. Participants were asked to report their emotions and their reactions to social interactions once each day, at the end of the day. While daily reports are subject to less bias than retrospective reports spanning a wider range of time (Robinson & Clore, 2002), some bias may still have occurred. In this study, retrieval bias was reduced by asking participants to report the most emotion they felt during the day and to think back to the three longest social interactions of their day, as emotional peaks and interactions of long duration are more likely to be remembered and reported accurately (Fredrickson & Kahneman, 1993).

A fourth concern, specific to Study 3, lies with demand effects and observation effects. Participants in Study 3 showed significant growth in positive emotions and other-focus over time, regardless of baseline vagal tone or meditation condition. Because increases occurred in both the meditation and non-meditation conditions, the changes may be attributed to the self-reflection required to complete the daily reports for the study. The fact that participants showed growth across conditions and RSA levels suggests that participation in the study itself impacted participants' perceptions of their daily interactions.

A strength of these data is the wide age range of participants across the various samples. Two samples (Studies 1 and 2) were composed of undergraduates, while Study 3 engaged a wide range of working adults. Much of the research on vagal tone has been conducted with children and infants. These data generalize the effects of vagal tone on other-focus beyond childhood, an important extension given that physiological changes characterize the maturation process.

An additional strength specific to Study 3 is the longitudinal and behavioral nature of the data. Despite years of theoretical work proposing vagal tone as a promoter of social engagement (Porges, 1995, 1998, 2003, 2007), few studies have found evidence to connect baseline vagal tone to positive emotions or enhanced quality of social interactions. The few that have found such relationships, such as the Eisenberg et al. (1995) study of parental reports of children's social behavior or Calkins' research on childrens' temperamental reactivity to threatening situations, have utilized longer observational time spans or behavioral reporting rather than self-reported trait measures. Those studies, in combination with the findings here, suggest that researchers exploring the effects of the vagus nerve may wish to move more decisively toward behavioral measures and longer time spans of observation when investigating vagal influences. The effects of vagal activity on other-focus may be subtle, vulnerable to contextual and self-report biases and requiring a more fine-grained approach to observation and measurement.

The Other-Focus Model: What Has Been Explored?

The data from these studies provide an initial exploration of several portions of the other-focus model. First, the contention that vagal activity predicts other-focused positive attention and positive emotions was addressed by the longitudinal analyses of Study 3, in which participants high in vagal tone showed greater growth in positive social attunement and positive emotions over the nine weeks of the study. In these data, vagal activity at baseline was linked to other-focused behavior as measured by positive social attunement during social interactions. Future studies should test this association using causal paradigms to investigate whether experienced other-focus also mediates the relationship between vagal tone and prosocial behavior, as predicted by the model.

Second, the contention that high levels of vagal activity will lead to increased psychological health and social bonds is supported by the positive correlations between vagal reactivity to low-arousal stimuli and extraversion, and between baseline vagal tone and the priority a person places on being a moral, prosocial person. Extraversion is an indicator of gregariousness, positive emotionality and psychological health (McCrae & Costa, 1991), while an investment in prosocial morality suggests an individual who is socially embedded in his or her community and society.

Third, progesterone was used as a representative of affiliation-oriented hormones such as oxytocin. In the model, oxytocin (or progesterone) was hypothesized to promote affiliation through activation of the vagus. In Study 3, progesterone was found to be significantly positively correlated with baseline vagal tone for males and meditators, providing an initial link between affiliation hormones and the vagus nerve. Future work with larger samples should explore the nature and direction of the causal mechanisms that underlie this link.

Fourth, the other-focus model proposes that frequent other-focused moments breed a greater tendency to engage in other-focus in the future. In Study 3, individuals who spent nine weeks engaging in lovingkindness meditation, a meditative practice that cultivates positive emotions and positive other-focused attention, showed increases in baseline vagal tone relative to participants who did not engage in meditation. As vagal tone, in turn, has been found to predict positive emotions and other-focused attention, this finding hints at a potential upward spiral of other-focus.

Chapter 5

Conclusion

The studies described here could stand solely as explorations of the role of the vagus nerve in social behavior and emotions, and as such would contribute to the psychophysiological literature on vagal tone and RSA. More importantly, however, these studies provide some initial footholds for the process model of other-focus, a model that attempts to draw together work on hormones, the vagus nerve, emotions, social behavior and health to understand how psychological and physiological systems work together to produce lives that are good both for ourselves and for our communities. The other-focus model assumes that evolution shaped humans to pursue relationships, just as it shaped them to pursue safety, food and sex. When other needs are temporarily satisfied, the other-focus model hypothesizes that attention turns to cues for social safety and receptivity. The other-focus model describes, and these data support, the prediction that some elements of our physiology urge us toward affiliation, which in turn makes us more interested in others and more open to engaging in relationships and, ultimately, happier. While there are risks inherent in reaching out to strangers in good faith, there are also many benefits. Evolution seems to have shaped human beings in such a way that when reason fails, our physiology and our feelings combine to push us out the door and toward social contacts.

The other-focus model has the potential to answer pressing questions within both social and health psychology. For instance, social support has long been linked to cardiovascular health and longevity (Uchino, Cacioppo and Keicolt-Glaser, 1996). By providing a model of other-focus that demonstrates how physiological and psychological factors relate both in the moment and over time, the other-focus model describes factors that mediate the relationship between social support and health in testable ways. In addition, the other-focus model provides a link between psychophysiological theories that explain the neurological and chemical antecedents of other-focus (Henry & Wang, 1998; Taylor et al., 2000; Carter, 2003; Uvnas-Moberg, Arn & Magnusson, 2005; Porges, 1998, 2003, 2007) and social psychological theories that explore the psychological characteristics of other-focused states and their consequences for cognition, affect, behavior and well-being (Mikulincer & Shaver, 2007; Brown & Brown, 2006; Fredrickson, 1998, 2001).

By combining insights from multiple theoretical traditions, the other-focus model is able to make broad predictions concerning when and how an other-focused state may come to be elicited, the manner in which it is manifested, and its psychological, physiological and social consequences over time. While some of the connections within the other-focus model are included in existing theoretical perspectives, a comprehensive social psychophysiological model encourages insight across the entirety of the other-focus process, which has not been attempted within existing theoretical frameworks. The other-focus model serves as a hypothesis-generating framework with which to organize psychological and physiological research on other-focus. By combining insights from multiple theoretical perspectives, it is my hope that the other-focus model will spur research in and contribute to the understanding of the complex worlds of affiliation, emotion and health.

Tables

Table 1

	Construal	Oxytocin	Vagal activity	Positive emotions	Other-focused positive attention	Positive social behavior	Social bonds	Health	Upward spiral
Calm-and-Connect (Uvnas-Moberg, 2003)		X				X	X	X	X
Tend and Befriend (Taylor et al., 2000)	X	X					X	X	
Polyvagal Theory (Porges, 1995; 2007)			X	X	X		X		
Attachment Theory (Miklincer & Shaver, 2007)	X			X	X			X	X
Selective Investment Theory (Brown & Brown, 2006)				X		X	X		
Broaden-and-Build Theory of Positive Emotions (Fredrickson, 1998)				X	X				X
Synthetic Other-Focus Model	X	X	X	X	X	X	X	X	X

Table 2

Means and Standard Deviations for Measured Variables by Experimental Condition

	Waitlist Control		Meditators	
Variable	Mean	SD	Mean	SD
Time spent meditating	2.36	6.72	12.46	15.22
Time 1 Baseline RSA	0.07	0.04	0.09	0.07
Time 2 Baseline RSA	0.08	0.08	0.10	0.08
Baseline Progesterone	93.17	38.28	75.41	44.42
Social Tuning	4.76	1.42	4.93	1.59
Social Closeness	4.82	1.53	4.79	1.77
Daily Positive Emotions	2.69	0.95	2.98	0.89

Note: The potential range for Social Tuning and Social Closeness was 1 to 7, for Daily Positive Emotions 1 to 5, for Time spent meditating 0 to 125 minutes, and for baseline RSA 0.0012 to 0.3413, across conditions.

Table 3

Results of Hierarchical Linear Regression Analyses

	Positive Social Attunement				Daily Positive Emotions			
	β	SE(β)	*z*(60)		β	SE(β)	*z*(60)	
Time	0.012	0.003	4.780	***	0.002	0.001	3.060	**
Gender	0.436	0.622	0.700		-0.109	0.197	-0.550	
Study condition	0.001	0.008	0.000		0.166	0.193	0.860	
Time spent meditating	0.003	0.008	0.360		0.004	0.002	2.230	*
Baseline RSA	-6.462	5.175	-1.250		-0.181	1.632	-0.110	
Time spent meditating x Time	0.000	0.000	1.460		0.000	0.000	0.740	
Time spent meditating x RSA	0.475	0.126	3.770	***	0.109	0.033	3.300	**
RSA x Time	0.239	0.047	5.060	***	0.059	0.012	4.790	***
Time spent meditating x Time x RSA	-0.011	0.003	-3.500	***	-0.002	0.001	-2.550	*

*** $p < .001$, ** $p < .01$, * $p < .05$

Figures

Figure 1

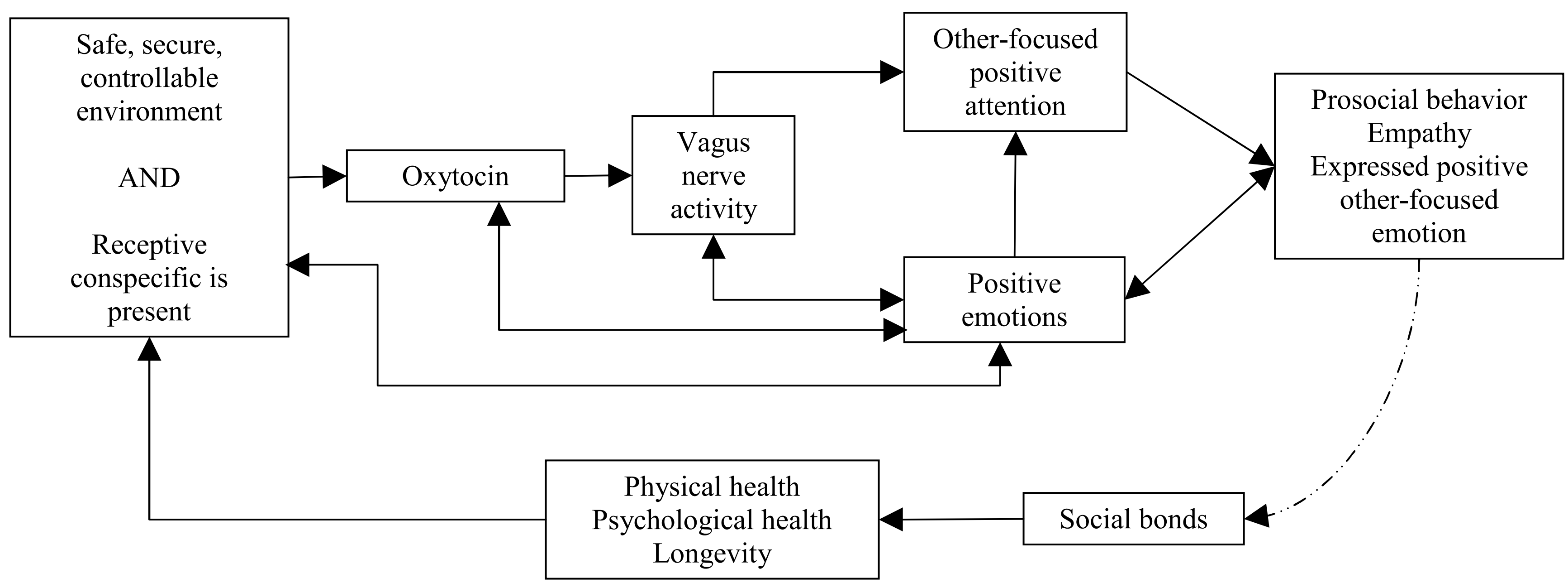
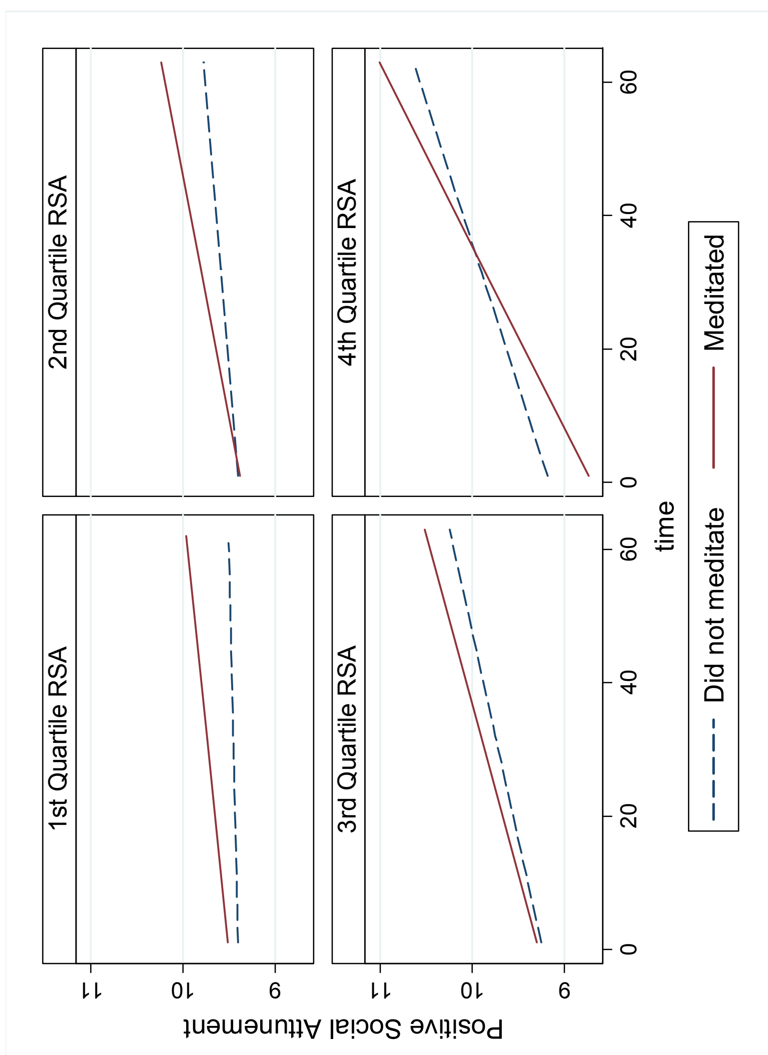
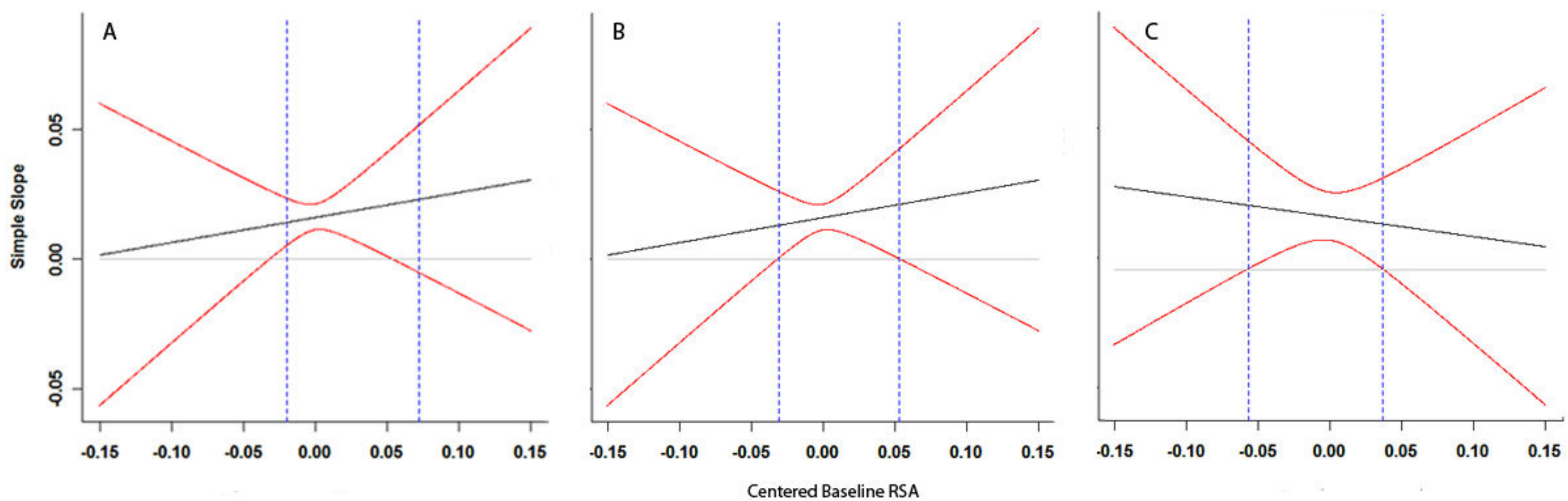


Figure 2



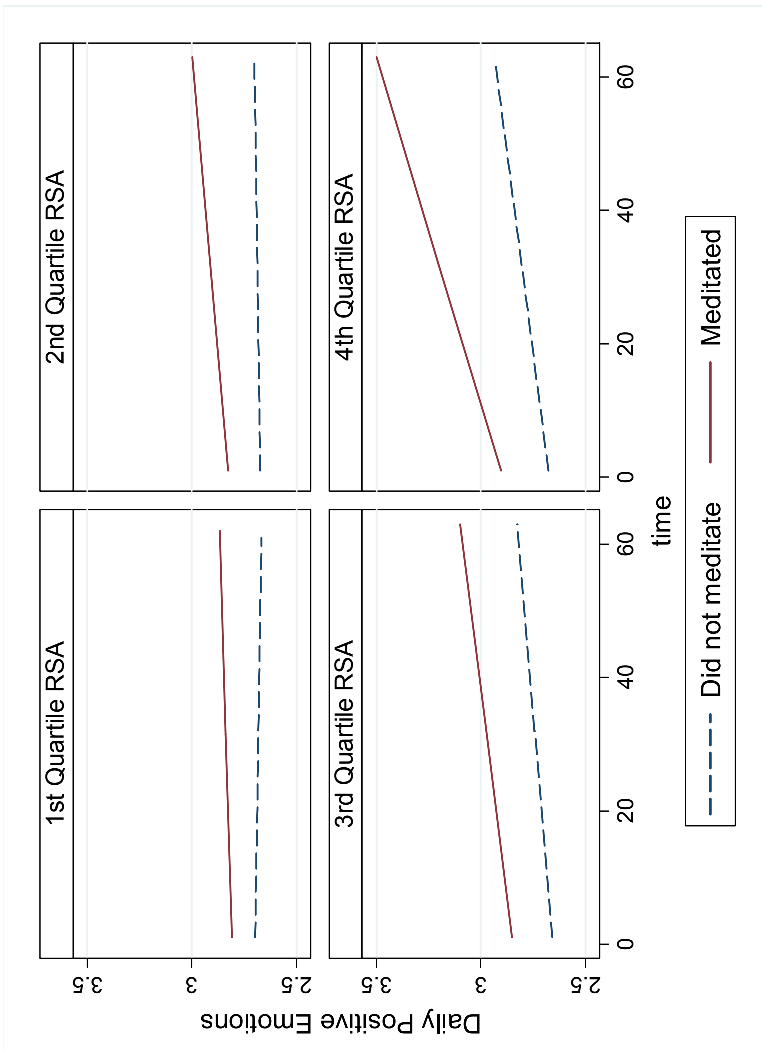
1st Quartile RSA
2nd Quartile RSA
3rd Quartile RSA
4th Quartile RSA
Positive Social Attunement
9
10
11
0
20
40
60
time
Did not meditate
Meditated

Figure 3



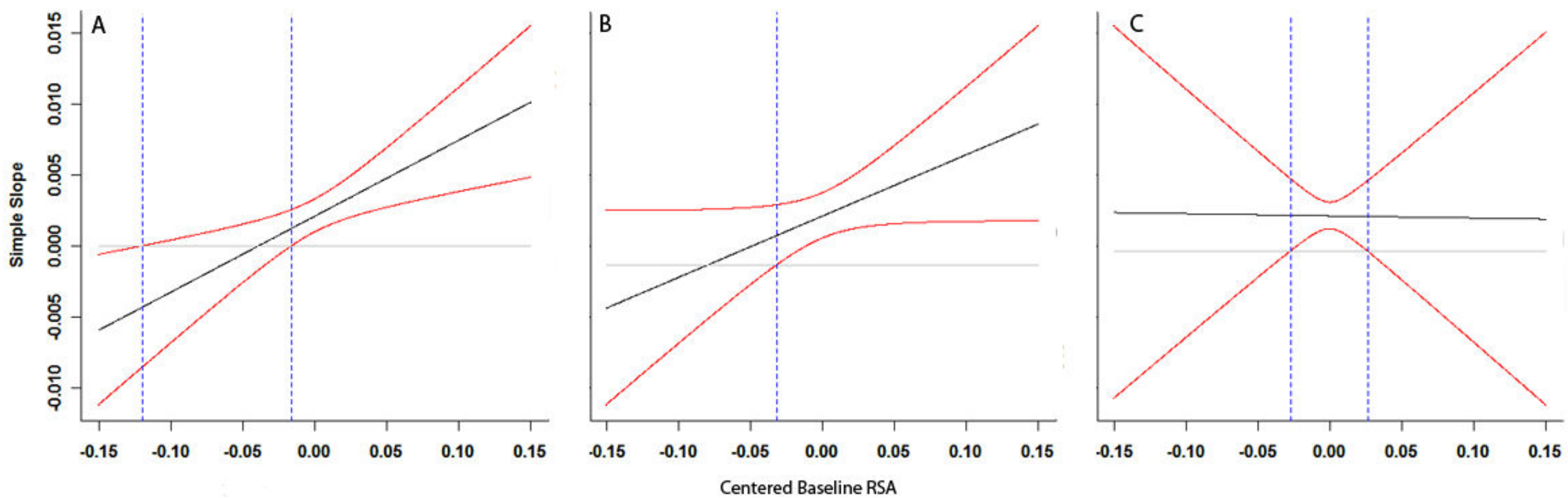
A
B
C
Simple Slope
0.05
0.00
-0.05
-0.15
-0.10
-0.05
0.00
0.05
0.10
0.15
Centered Baseline RSA

Figure 4



1st Quartile RSA
2nd Quartile RSA
3rd Quartile RSA
4th Quartile RSA
Daily Positive Emotions
2.5
3
3.5
0
20
40
60
time
Did not meditate
Meditated

Figure 5


A
B
C
Simple Slope
0.015
0.010
0.005
0.000
-0.005
-0.010
-0.15
-0.10
-0.05
0.00
0.05
0.10
0.15
Centered Baseline RSA

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